PHOSPHORUS FERTILIZATION FOR DRYLAND TARO

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Abstract

This report summarizes the results of a single experiment in determining the phosphorus requirement for Chinese taro. Based upon the predicted results, 3,571 lbs treble superphosphate gave the highest no.1 and marketable corm yields. The maximum predicted net revenue of marketable corms, $13,608, was attained at 3,061 lbs of treble superphosphate per acre. This was a 20 percent increase in net revenue as compared to applying no treble superphosphate. For Hilo soils with approximately 46 ppm available phosphorus, the preliminary recommendation for treble superphosphate is 3,061 lbs per 14,520 plants per acre as a pre-plant application.

Introduction

A phosphorus fertilization experiment was conducted in Hilo, Hawaii, with Chinese taro (Colocasia esculenta (L.) Schott variety 'Bun Long'). Four rates of applied phosphorus, in a randomized complete block design, with three replicates, were compared to determine the amount of fertilizer required to achieve the maximum and economic yield for dryland taro. The test site which had not been previously planted to edible ginger, was at an elevation of approximately 500 feet and the taro was grown under rainfed conditions.

The experimental setup is described in Appendix 1.

Observed Corm Yield

The observed no.1 and marketable corm yield per acre increased slightly with increasing treble superphosphate (Table 1). The highest observed average yield of no.1 corms (32,622 lb/acre) and marketable corms (32,912 lb/acre) were produced with the application of 5,051 lbs treble superphosphate per acre. The maximum average corm size, 2.49 lb, was attained at 1,684 lb treble superphoshate per acre. The off-grade corm yield decreased with increasing treble superphosphate but the differences were not statistically significant.

Predicted Corm Yield

Prediction equations were derived from the observed data and the predicted yields are listed in Table 2. The maximum predicted marketable yield (35,546 lb per acre) was attained at 3,571 lb treble superphosphate per acre. On the basis of only the cost of treble superphosphate, the maximum predicted net revenue ($13,608) was attained at 3,061 lb treble superphosphate per acre (Table 3). The difference between the maximum and the lowest net revenue is $2,291. This is a 20 percent increase in net revenue.

The observed and predicted average no.1 corm yield per acre with increasing treble superphosphate is shown in Figure 1. The predicted percent no.1 corms with increasing treble superphosphate is shown in Figure 2. Phosphorus appears to have a role in increasing percent no.1 corms.

Tissue Analysis

In each treatment, the most recent, fully expanded leaves were sampled at 8, 17, 26, and 34 weeks after planting. Leaf phosphorus levels at 17 weeks were the most closely related to yield.

Above the level of 0.38 to 0.39 percent leaf phosphorus, yields are not expected to increase with application of phosphorus fertilizer. This may be considered the adequate level of leaf phosphorus for taro. The other nutrients appeared to be at adequate levels.

Soil Analysis

The pre-plant phosphorus level, 46 ppm, may have been close to adequate for Chinese taro because additional phosphorus only slightly increased corm yield as can be seen in the slopes of the observed and predicted yields per acre (Figure 1). In addition, the initial available phosphorus in the 0 lb per acre treble superphosphate treatment did not change very much at the end of the crop cycle. On the basis of the amounts of phosphorus in the post-harvest soil analysis (Appendix 1), available phosphorus can build up with high treble superphosphate applications and that the residual phosphorus would probably be adequate to support subsequent taro plantings. Treble super-phosphate (0-45-0) has 20 percent phosphorus and 13 percent calcium. Therefore, calcium is also an added nutrient along with treble superphosphate as is shown in the post-harvest soil analysis. If pH adjustment is not necessary, calcium nutrition could be supported with high treble superphosphate applications.

Rainfall

The weekly rainfall during the cropping period is shown in Appendix 2. The total amount of rain measured for this crop was 143.7 inches. At the end of the first three months, 29.9 inches were recorded; the second three months, 40.3 inches; and for the last three months, 73.5 inches.

Preliminary Treble Superphosphate Recommendation

For Hilo soils, with approximately 46 ppm available phosphorus, the preliminary recommendation for treble super-phosphate is 3,061 lb per 14,520 plants per acre as a preplant application.

References

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Kagbo, R.B., R.S. dela Peña, D.L. Pluncknett and R.L. Fox. 1977. Mineral Nutrition of Taro (Colocasia esculenta) with Special Reference to Petiolar Phosphorus Level and Phosphate Fertilizers. Proc. of the 3rd Symp. of the Int. Soc. for Tropical Root Crops. Ed. Colin L.A. Leakey, pp 138-144.

Table 1. Observed Average Corm Yields by Treatments

Lbs per Acre:		Avg.lbs	Corm Yield (Lbs per Acre):[1]		
TSP	(P)[2]	No.1 Corm	No.1	Off-grade	Marketable
0	(0)	2.11	28,028	1,210	29,418
561	(110)	2.45	28,992	629	29,621
1,684	(330)	>2.49	31,750	484	32,234
5,051	(990)	2.31	>32,622	290	>32,912

[1] Based upon 14,520 plants per acre and adjusted for No.1 and off-grade yield by treatment.
[2] Treble superphosphate and phosphorus.

Table 2. Predicted Corm Yield per Acre

Lbs per Acre:		Corm Yield (Lbs per Acre):[1]		
TSP	(P)[2]	No.1	Off-grade	Marketable
0	(0)	27,381	1,042	28,423
510	(100)	29,240	1,112	30,352
1,020	(200)	30,807	1,167	31,974
1,531	(300)	32,090	1,208	33,298
2,041	(400)	33,090	1,235	34,325
2,551	(500)	33,802	1,247	35,049
3,061	(600)	34,216	1,246	35,462
3,571	(700)	>34,316	1,230	>35,546
4,082	(800)	34,081	1,200	35,281
4,592	(900)	33,482	1,156	34,638
5,102	(1000)	32,488	1,097	33,585

[1]Based upon 14,520 plants per acre, predicted % no.1 corms and 3.3 % average off-grade corms.
[2]Treble superphosphate and phosphorus.

Table 3. Predicted Revenue per Acre based on Marketable Corms[1]

Lbs per Acre:		Gross	Fertilizer	
TSP	(P)[2]	Revenue[3]	Cost[4]	Net Revenue
0	(0)	$11,317	$0	$11,317
510	(100)	$12,085	$86	$11,999
1,020	(200)	$12,731	$172	$12,560
1,531	(300)	$13,259	$257	$13,001
2,041	(400)	$13,668	$343	$13,325
2,551	(500)	$13,957	$429	$13,528
3,061	(600)	$14,122	$515	>$13,608
3,571	(700)	$14,157	$600	$13,556
4,082	(800)	$14,052	$686	$13,366
4,592	(900)	$13,797	$772	$13,025
5,102	(1000)	$13,379	$858	$12,521

[1]Based upon 14,520 plants per acre, predicted % no.1 corms and 3.3 % average off-grade corms.
[2]Treble superphosphate and phosphorus.
[3]Price per lb for no.1 corms is $0.40 and off-grade is $0.35.
[4]Cost of Treble superphosphate is $13.45 per 80 lb bag.

Figure 1.

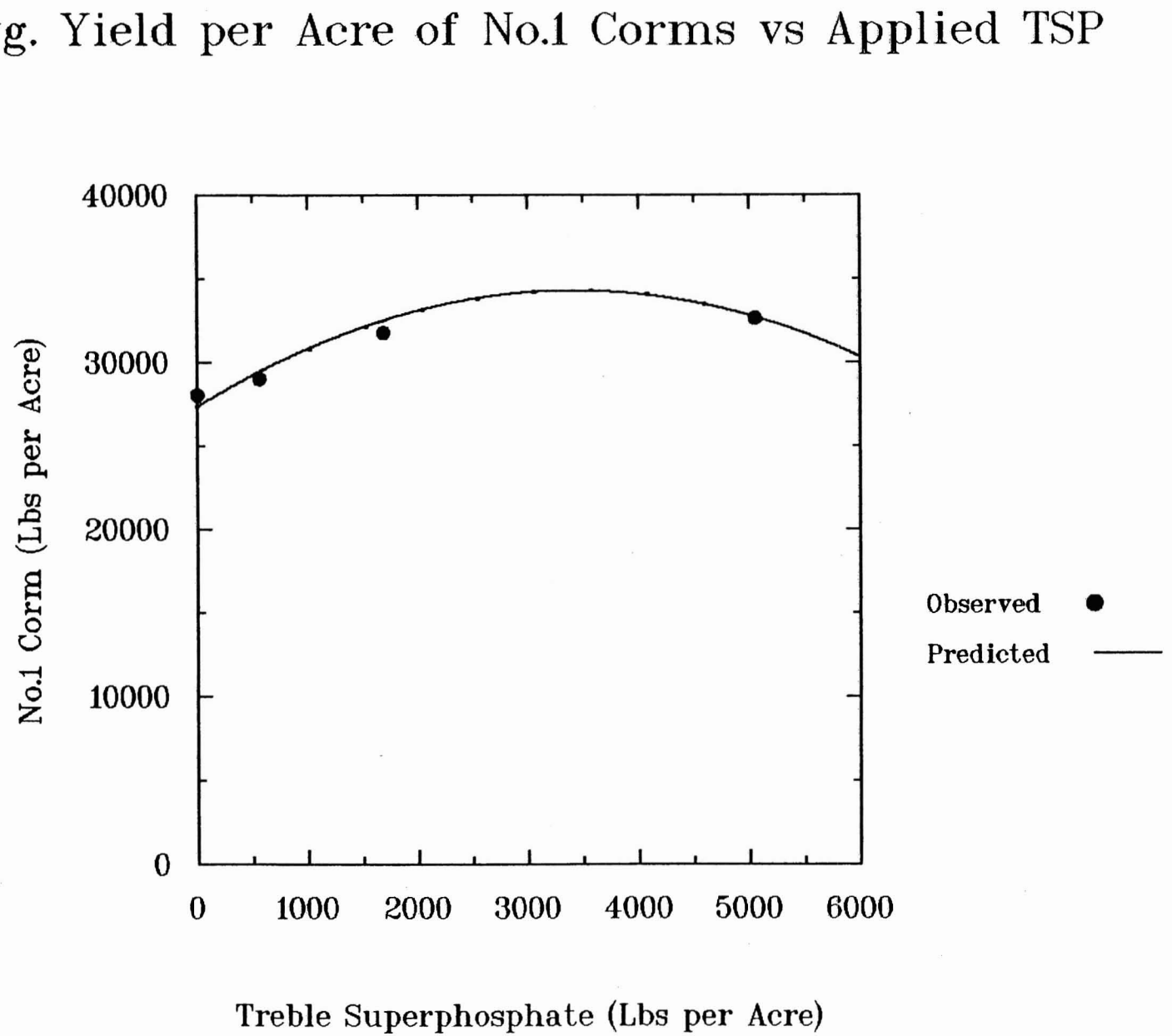
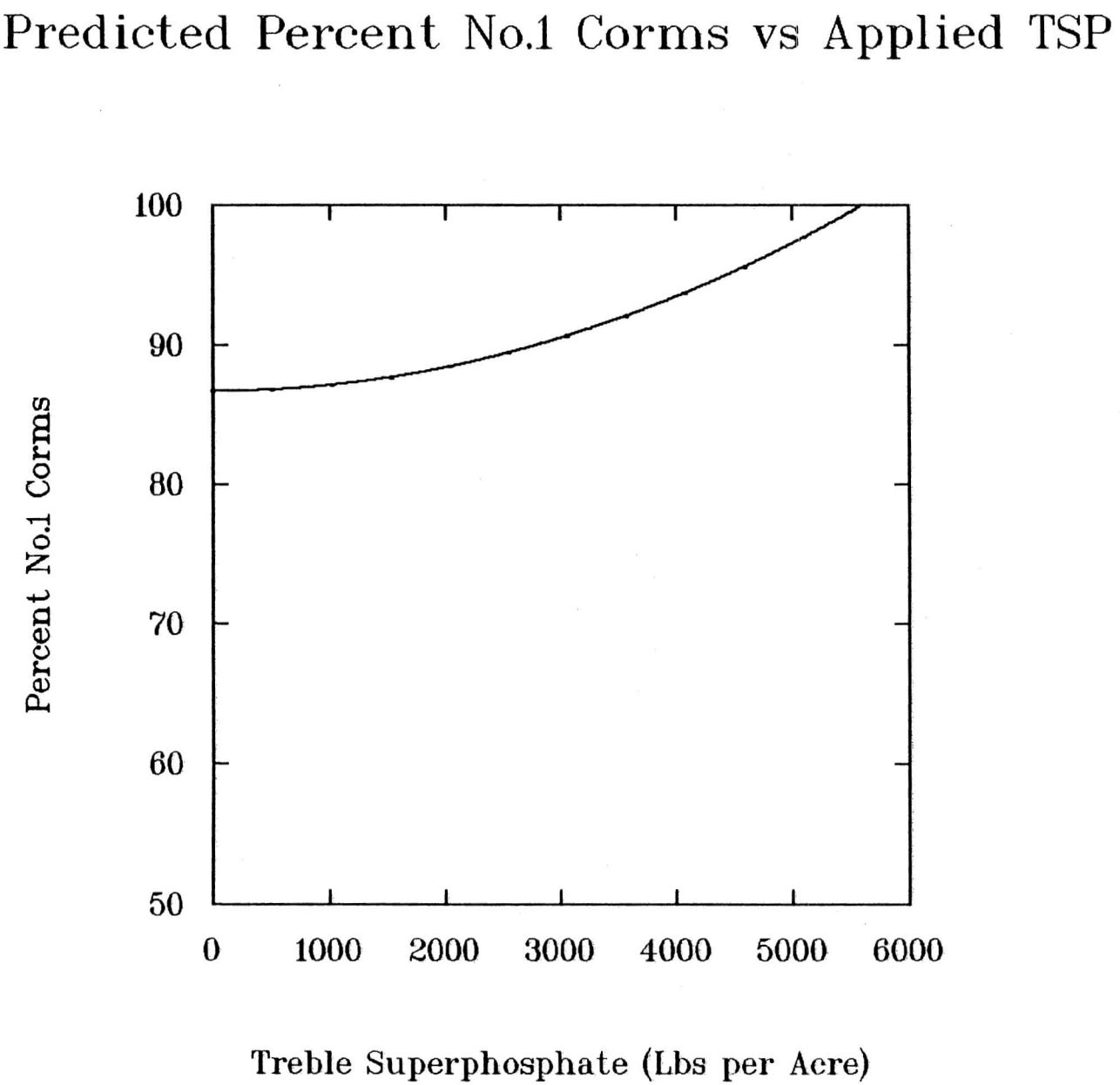

Avg. Yield per Acre of No.1 Corms vs Applied TSP
No.1 Corm (Lbs per Acre)
40000
30000
20000
10000
0
0
1000
2000
3000
4000
5000
6000
Treble Superphosphate (Lbs per Acre)
Observed
Predicted

Figure 2.


Predicted Percent No.1 Corms vs Applied TSP
Percent No.1 Corms
100
90
80
70
60
50
0
1000
2000
3000
4000
5000
6000
Treble Superphosphate (Lbs per Acre)

Appendix 1. Experimental Setup

The total amount of treble superphosphate for each treatment was banded and tilled in 6 inch-deep furrows prior to planting. Applications of 695 lbs urea per acre and 630 lbs muriate of potash per acre were divided into six equal doses and banded at monthly intervals. The first dose of nitrogen and potassium was applied at pre-plant and tilled with the phosphorus treatment. Approximately 1 to 2 tons per acre of crushed coral (calcium carbonate) was broadcast and incorporated to raise soil pH to 6.

The soil on which this experiment was conducted is classified as the Hilo series. The pre-plant soil analysis, sampled November 10, 1987 and the post-harvest soil analysis, sampled January 25, 1989 were averaged and are presented below.

Pre-plant Soil Analysis:[1]

pH	P ppm	K ppm	Ca ppm	Mg ppm[2]
5.6	46	66	367	165

[1] pH - 1:1 soil:water; P - Modified Truog extractant; K,Ca,Mg, - N ammonium acetate, pH 7.0
[2] P = phosphorus; K = potassium; Ca = calcium; Mg = magnesium

Post-harvest Soil Analysis:[1]

Lbs per Acre:						
TSP	(P)[2]	pH	P ppm	K ppm	Ca ppm	Mg ppm[3]
0	(0)	5.9	41	173	773	147
561	(110)	5.9	64	167	843	167
1,684	(330)	6.0	137	127	1227	180
5,051	(990)	6.1	508	147	1773	187

[1] pH - 1:1 soil:water; P - Modified Truog extractant; K,Ca,Mg, - N ammonium acetate, pH 7.0
[2] Treble superphosphate and phosphorus.
[3] P = phosphorus; K = potassium; Ca = calcium; Mg = magnesium

Seed material (hulis) which were about 2 inches in diameter at the base were planted approximately 4 inches deep. Hulis were spaced 1 foot apart within rows and 3 feet apart between rows (population of 14,520 plants per acre). Twenty-five plants were harvested from each plot (9 x 27 ft), 9 months after planting. The average corm weights per plot were recorded and the data reported were averaged over three replicates. The planting date was April 25, 1988 and the harvest date was January 23, 1989.

Acknowledgements:

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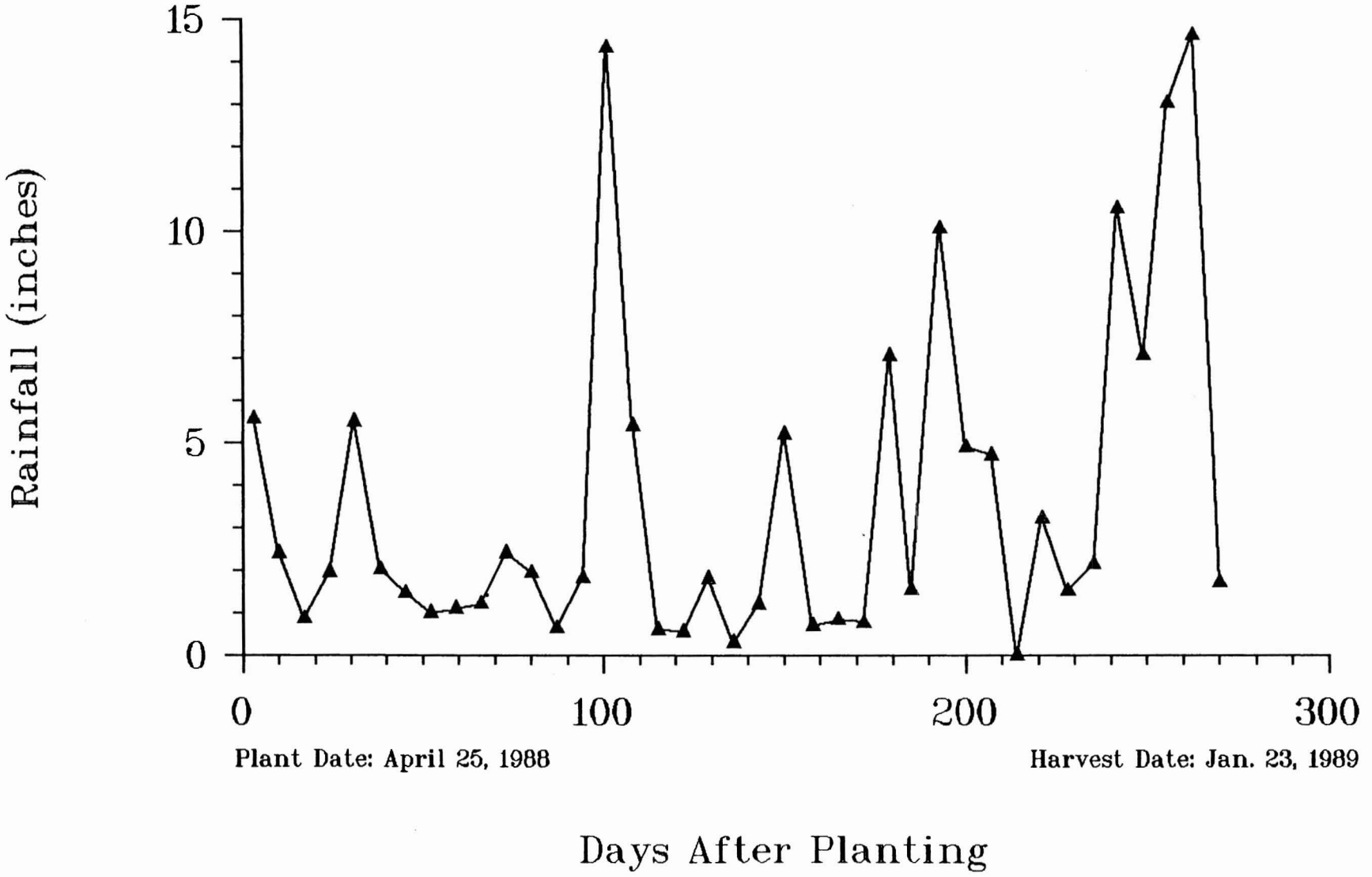
Appendix 2.

Weekly Rainfall vs DAP

Phosphorus Fertility



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